New Empirical Fitting Functions of the Lick/IDS indices using MILES

J.M. Martín-Hernández[1], E. Mármol-Queraltó[1], J. Gorgas[1], N. Cardiel[1], P. Sánchez-Blázquez[2], A. J. Cenarro[3], R. F. Peletier[4], A. Vazdekis[3], and J. Falcón-Barroso[5];
e-mail: josemm@astrax.fis.ucm.es

Abstract We are presenting new empirical fitting functions for the Lick/IDS line-strength indices as measured in MILES (Medium-resolution INT Library of Empirical Spectra). Following previous work in the field, these functions describe the empirical behaviour of the line-strength indices with the atmospheric stellar parameters. In order to derive the fitting functions we have devised a new procedure which, being fully automatic, provides a better description of the line-strength index variations in the stellar parameter space.

1 Introduction

Line-strength indices are a measure of the intensity of certain spectral features compared with the local continnuum. They constitute a fundamental part of the models that try to identify the stellar content of galaxies. In particular, they are essential in the construction of evolutionary synthesis models. Although the first studies of stellar populations in early type galaxies were made using photometry in those sistems, nowadays the most usual way of carrying out such research is by the analysis of certain spectral absortion features. At this point, the development by the Lick group, (see [1], [4], [2], [5], [7]) of an indices system that allows to objectively measure the spectral features in an integrated spectrum constituted a breakthrough in the field.

We have developed a new fitting procedure more objective and fully authomatic to derive improve fitting functions for the Lick system indices. These fitting func-

[1]Dpto. Astrofísica, Universidad Complutense de Madrid, Avda. Complutense s/n, 28040 Madrid, Spain
[2]University Of Central Lancashire, Centre for Astrophysics, Preston, PR1 2HE
[3]Instituto de Astrofísica de Canarias, Vía Láctea s/n, 38200, La Laguna, Spain
[4]Kapteyn Astronomical Institute, University of Groningen, 9700 AV Groningen, The Netherlands
[5]Sterrewacht Leiden, Niels Bohrweg 2, 2333 CA, Leiden, The Netherlands

tions estimate the line-strength of a spectral feature as a function of the the atmosferic parametres: effective temperature, gravity and metallicity. In this work we have made use of the library of empirical spectra MILES ([3], [6]). This is a new stellar library specially developed as a tool for models of stellar population synthesis. The library is composed of 985 stars whose spectra cover a range of $\lambda\lambda 3500 - 7500$ Å, with a 2.3Å spectral resolution (FWHM) and it is flux calibrated. The spectral resolution, spectral-type coverage (as shown in Figure 1), flux-calibration accuracy and number of stars represent a substantial improvement over previous libraries used in population-synthesis models.

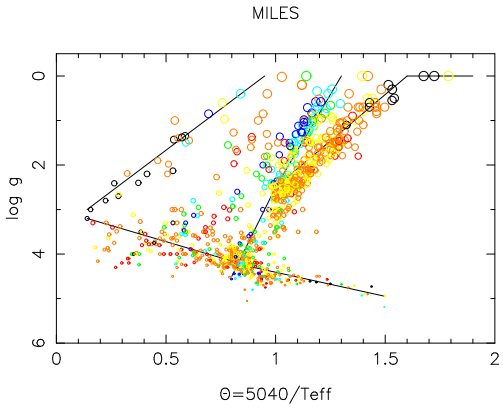

Fig. 1 Gravity vs temperature diagram of the stellar library MILES.The lines are paths for representing the fitting functions in Figures 2 and 3. The colour code means: red ([Fe/H] > 0.25), orange ($0.25 >$ [Fe/H] > -0.25), yellow ($-0.25 >$ [Fe/H] > -0.75), green ($-0.75 >$ [Fe/H] > -1.25), blue ($-1.25 >$ [Fe/H] > -1.75) and dark-blue ($-1.75 >$ [Fe/H]). The symbol sizes increase with decreasing gravity.

2 The Moving-Boxes Method

The moving-boxes method is an automatic procedure to derive fitting functions. The procedure consists of the fitting of local polynomials (up to the 2nd degree in the three atmospheric stellar parameters) in a narrow temperature window ($\Delta\theta = 0.2$). These windows are moved at small steps ($\Delta\theta = 0.001$) covering the whole temperature interval. When necessary, the fits are computed independently for two gravity intervals (dwarfs and giants) or two metalicity intervals (high and low metalicity). Finally, the predicted index for a given set of stellar parameters in derived from a weighted average of the fitting functions corresponding to all the moving boxes in which the input parameters were included. The moving-boxes method uses the same sample of boxes for all the different indices and thus avoids the subjectivity in the choice of stellar parameters intervals to fit each particular index. Due to its automa-

tism the method can be easily applied to new defined indices. The moving-boxes method is not a fully new method but a substantial improvement over the classic method ([5], [7]).

3 The Fitting Functions

In Figures 2 and 3 we present 24 calibrated Lick/IDS line strength indices. In each panel the fitting functions are represented for severals paths in the atmospheric parameter space for a given index. In fact, the result of the new fitting procedure is a subrutine that provides us with the index value for any given set of stellar parameters from the area covered by MILES.

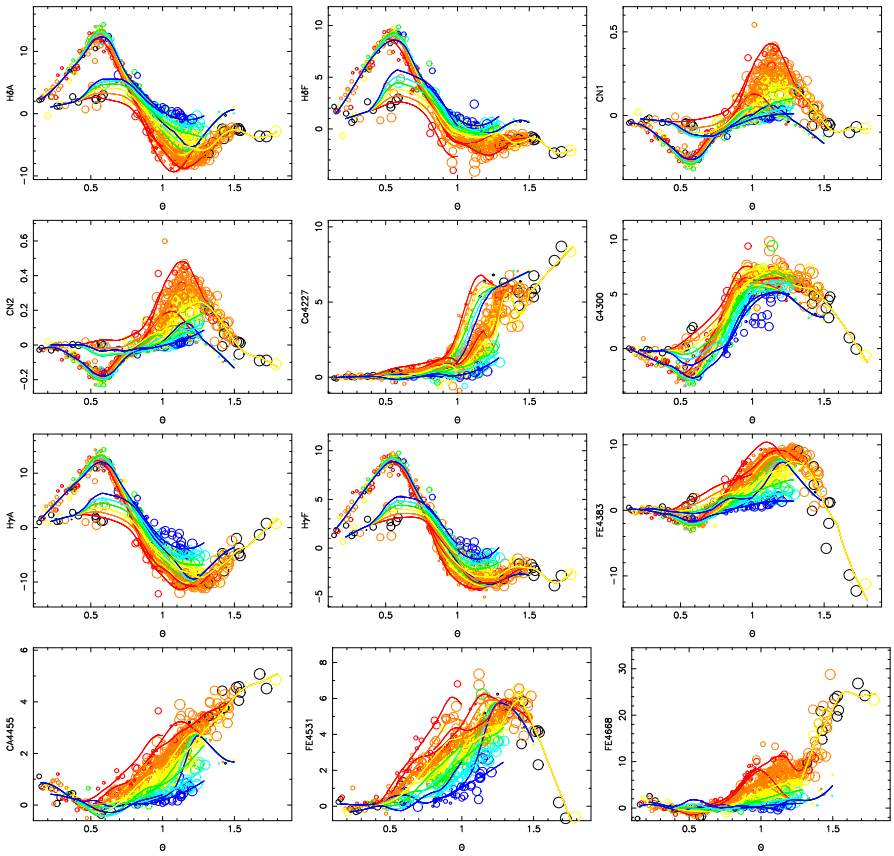

Fig. 2 The diferent panels show the new fitting functions for 12 Lick/IDS line strength indices as shown in the vertical axes. The lines represent the fitting functions for different metalicities (see colour code in Figure 1), evaluated along the stellar parameter secuences shown in Figure 1.

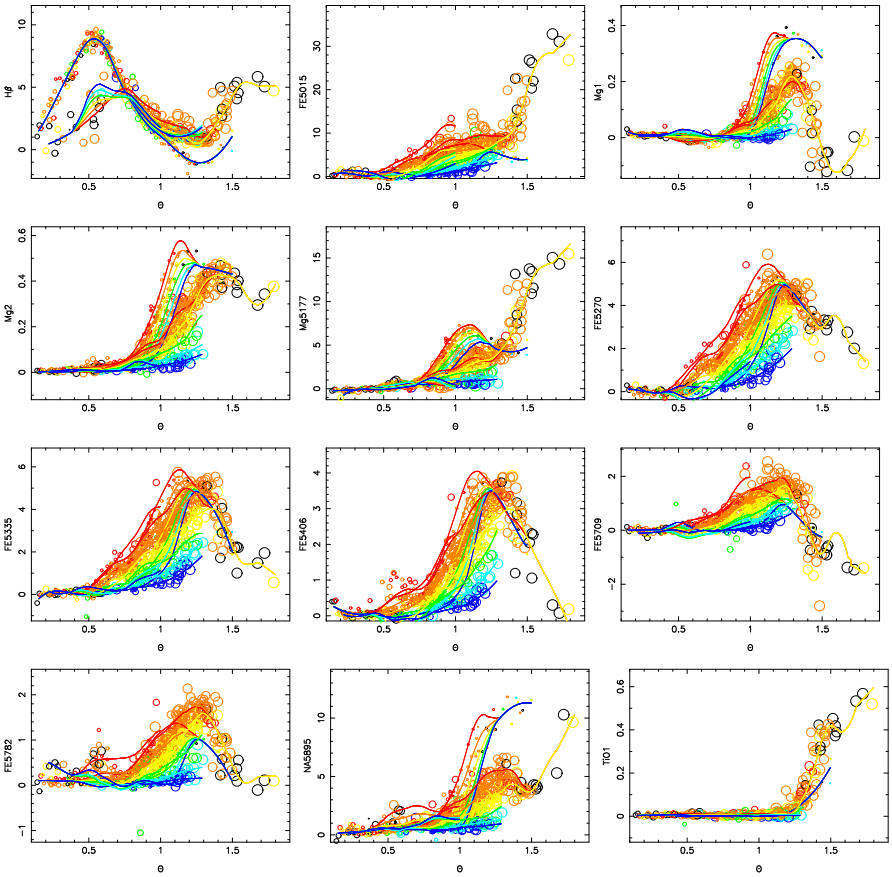

Fig. 3 New fitting functions for 12 more Lick/IDS line strength indices.

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